Rebranding education through FabLabs in developing countries

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Abstract

CircuiTricks is a start-up, by an 18 year old, which was born out of FabLab CEPT in Ahmedabad. The startup focused on creating Do It Yourself kits for school kids. It's first DIY kit allowed students to create working electronic circuits using pencils only! It was the first time graphite inside pencil was used to make circuits at a large scale. After the launch of the product at the Fab10 conference in Barcelona and its engagement in Maker Faire Bay Area, CircuiTricks partnered up with Intel education and travelled all across India to cover 100 schools and over 10,000 students where they conducted workshops with the kids, teaching them fabrication of circuits using pencils!

With the use of quantitative, qualitative and deductive data collected from workshops conducted with over 10,000 students across India (during February 2015 to March 2015) and concepts from behavioral economics and child psychology; the paper will focus on exploring theories for better education and student engagement in demographics with similar education system to India.

The major anti catalyst for developing countries to transform into developed countries is the presence of unstructured education. In India, for example, the high school education is often synonymous with "cramming". Hence, the theories for better education mentioned in this paper, make it of a great value to these countries.

Keywords : CircuiTricks, education, student engagement

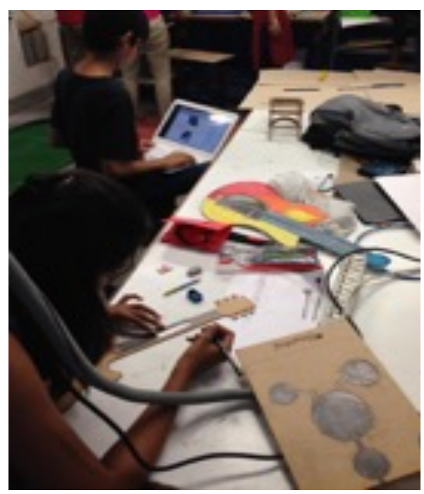
Introduction

What is education actually? What is knowledge? and What is learning? All of this may go hand in hand but all the topics are distinctly different from each other; yet, very well connected. Education derives from knowledge and knowledge derives from learning.

In today's world we see a drastic change in this pattern. There is education in schools, which is very well based on knowledge. However, none of this knowledge is derivative; meaning, none of this knowledge is received by kids through "learning". And is instead received by systematic instruction. This disturbance in the flow of education has lead to qualitative changes in the society. From broader view of kids not liking what they study to a deeper level of inability to think outside the box.

However, CircuiTricks - a company based in India (which started from a FabLab), challenged this perspective through the recent launch a product named "scribble your circuits kit"[1] in December 2014. This kit allowed kids to create working electrical circuits using pencil lines. The graphite in the pencil conducted electricity and the kit provided kids with a platform to approach everyday life objects (such as a pencil), differently[2].

Picture 1: Kids work with CircuiTricks at FabLab CEPT.



This product reached to over 10,000 students across 100 schools in India and started a foundation for kids to think beyond their circumference, to approach things around them in a different format and to question everything they see. Kids started to challenge their creativity and made things like a working guitar with pencil lines instead of strings, drums, ironman hand, interactive sketches and more.

With this we attempt to identify what happened between the kid and the CircuiTricks product that allowed the kid to approach things in a different manner. We also try to identify possible ways in which better learning happens in schools and how maker spaces like FabLabs have played a major role in doing so.

Therefore, the present investigation deals with possible pathways to **Rebrand education through FabLabs in developing education systems.**

Methodology

The workshop was distinctly divided into two major parts. Instruction/hands on and exploration. During the Hands on part, kids were engaged into imaginative thinking through thought provoking questions and were then gradually introduced to the concept of making circuits with pencils using the CircuiTricks kit. After which they had to work on hands on activities like making a greeting card using paper circuits, etc. In the exploration part, kids were prompted to apply their knowledge to daily life.

The investigation is to identify how children behave with different everyday life objects given to them. How do they behave before and after the instructions of use are specified. And how this behavior tells us something about the way they approach learning.

To do this, a series experiments were conducted in every workshop.

1. First, psychometric testing was used through oral questionnaires that were asked in general to all kids. With answers gained from this, we computed a generic scale for labeling kid's acceptance of 'approaching things differently' (using pencils to make circuits instead of writing).

2. Second, creative testing was used after learning the basics, kids were asked to make creative things such as greeting card, hat, paper craft using pencil circuits. They were introduced with two options of doing so. And their choice of options was then analyzed.

3. Third, motivation testing was carried out through simple ways of appreciation (e.g. Giving 'hi-fives' and appreciating in local language) to analyze how these methods of motivation had an impact on they way kids approached thinking.

One of the major factor that remained constant throughout all the experiments, was Interactive learning. Interactive learning can be greatly fostered at maker spaces like FabLabs, as these places not only have the mechanical resources for execution of an idea, but also have the human resources of like minded people who are always ready to help. One of the reasons CircuiTricks started at a FabLab CEPT (picture 1) was that making an interactive kit required an interactive environment for the makers to better understand what do they want to reflect in the product they develop.

A lot of kids with great potential were picked during CircuiTricks workshops to work on amazing projects like making a Glider, Wireless mouse, Copper Tape Touch Screen, Virtual Drums and more.

Experiment 1: Psychometric testing

An oral questionnaire is one of the best way to process a general psychometric analysis of the classroom as a whole. Asking a series of simple questions, kids were motivated for what is going to happen next, while also judging their curiosity level.

The judgement of their curiosity level was defined in an arbitrary curiosity scale, which was judged through a series of questions with answers that were limited to either "yes" or "no". These questions are as follows:

Table 1: Oral questionnaire
A more detailed version of these questions can be found in the Appendix 2.

Sr. No.	Question
1	Would you like to make new things?
2	Would you like to make a paper plane?
3	Would you like to make a kite?
4	Would you like to build a circuit?
5	Would you like to make a greeting card?
6	Would you like to make an origami?
7	Would you like to build a robot?
8	Would you like to build an iron man suit?

To quantify the results, a "yes" accounted for 1, while a "no" accounted for 0. Adding up all the "yes" and "no" (0s and 1s), we get a number which is the arbitrary curiosity level (ACL) of a child.

$$Arbitrary\ Curiosity\ Level\ (ACL) = \sum_{y=0}^{t-n} y$$

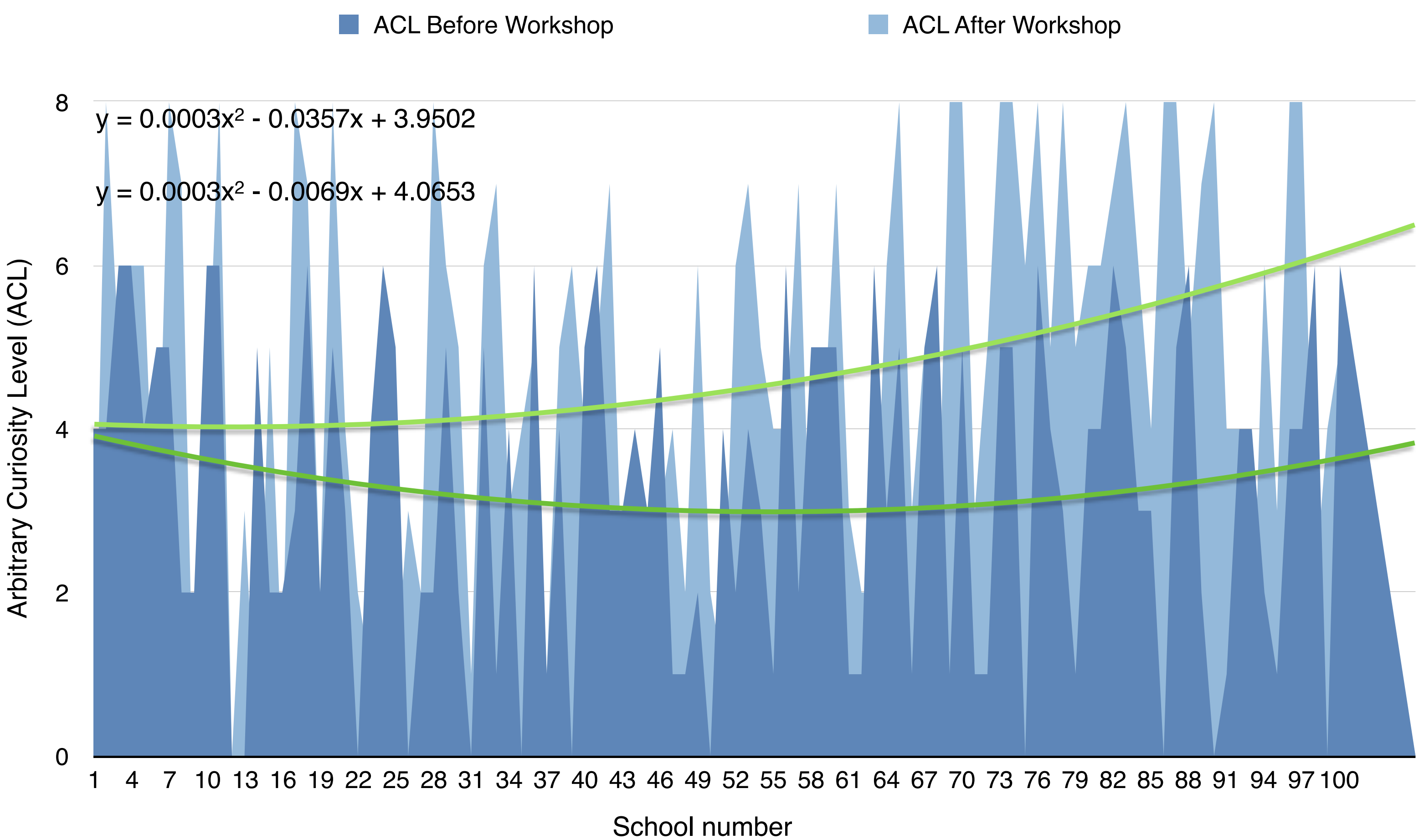
Variable	Definition	Value
y	yes	1
n	no	0
t	total	-

Kids were first asked a bunch of questions, if the majority answered “yes” the question was marked with 1. Else, it was marked with a 0. And the ACL of the class was calculated and recorded.

After the CircuiTricks workshop (where kids were introduced to the topic of making circuits using pencils and using everyday objects for creative purposes); the questions were asked again, and the ACL was calculated and recorded.

This was done through 100 schools across India, in every workshop. The purpose was to understand the rise/decline of the curiosity in kids. Before the workshop, kids approached pencils as an object of drawing and writing. In the workshop, kids were taught a different use of pencil (to draw circuits), with this they started to look at a pencil differently. After the workshop when they were asked the same questions again, we found that kids in majority of schools had their ACL levels raised, stating that they were now more excited to explore different things. The graph below reflects the same.

Graph 1: ACL Before and After workshop for 100 schools



What is interesting to know is that the trend line for the graph of "ACL After Workshop" and the trend line for the graph "ACL Before Workshop", have a positive growth at every corresponding point clearly stating the rise in curiosity levels of kids.

Before the workshop, kids are more likely to answer the questions 7 and 8 with a "yes". This is because the questions are more fictionalized, luring and exemplified, compared to other questions which are not fictionalized or exemplified.

During the workshop, kids received a great experience of:

1. Looking at things differently as they used a pencil for drawing circuits
2. Hands on activity as they make things like
   Greeting Cards (question 5),
   Paper Plane (question 2) and
   Circuits (question 4).
   These hands on activities prompt kids to do more!

After the workshop, kids have gained some experience of hands on activities and feel like exploring more ideas by making more things. This prompts them to reply "yes" to questions they previously replied "no" with. Hence, rising the figures of ACL calculations throughout the class.

To generalize, for better learning to happen and for evoking curiosity, it is necessary to provide kids with platform(s) to be more articulate through hands on activities and problem solving activities before introducing them to the content of study.

Experiment 2: Creative testing

During the workshop, the kids were made familiar with the concept of making circuits with pencils. Following which, the kids were then asked to make a simple greeting card[3]. In this greeting card, they had to put a simple LED that lights up using pencil circuits.

Before the kids started to work on this activity, we showed them two examples of existing greeting cards. This was done to understand the effect of introducing demo cards before work on the final outcome generated by the kids.

Procedure

First Scenario:

1. Familiarize kids with the procedure of the hands on activity (making a greeting card).
2. As an example of the outcome for this activity show them a card. We start with showing card 1 as this card is visually appealing for kids.
3. Allow the kids to work on their cards.
4. Record the kid's output in terms of visual similarity with card(s) shown.

Second Scenario:

5. Now show the kids another card (card 2). This card is different than card 1, and is slightly less visually appealing.
6. Allow the kids to work on their cards.
7. Record the kids's output in terms on visual similarity.

Picture 2: Cards introduced to kids

Outcomes and explanations

First Scenario:
First the kids were familiarized with an aesthetic and visually appealing greeting card, which had a nice painting accompanied with fine finishing of the pencil circuit. Once the kids experienced this card (Card 1); they were given space for making their own. As an end result, a lot of cards that started to appear were similar to the example card (Card 1) that was shown.

When the kids were introduced to Card 1, visual aspect of the card acted as a subliminal image within the kids' mind, triggering a subliminal stimuli which prompted the kids to make similar drawings and cards as portrayed by Card 1.

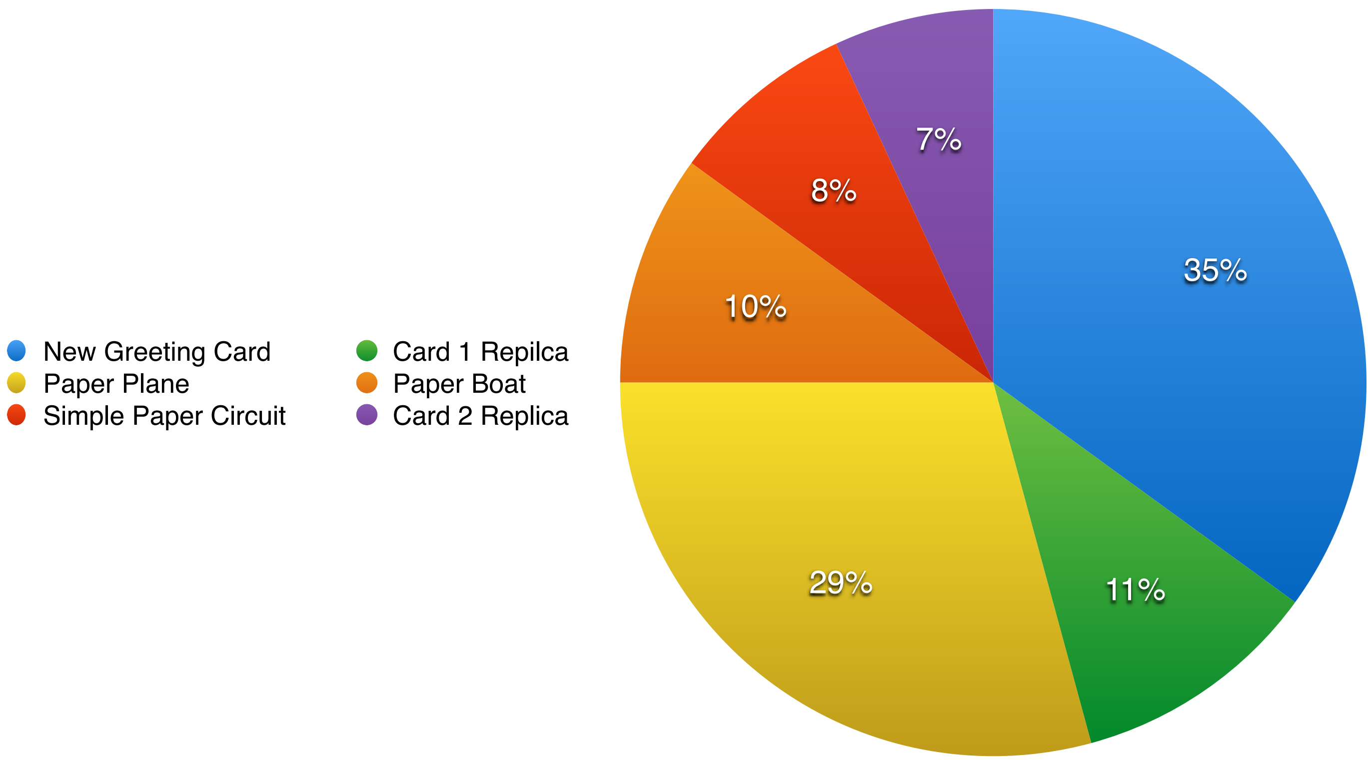
Picture 3: Similarity in cards made

Second Scenario:
The time, the kids were introduced to a slightly less visually appealing card (Card 2). It was observed that the kids started to make other kind of greeting cards that were totally different than Card 1. Some students also jumped to make things like a paper plane, that lights up as it flies and other things that could completely be termed at "out of the box".

The second scenario was a staggering discovery! The similarity of kids' work compared to the examples shown was drastically reduced. The change noted over 100 workshops, has

been averaged to one workshop and is depicted in the graph below. Showing the projects kids worked on after the introduction of Card 2, as mentioned in the second scenario.

Graph 2: Projects worked on after introduction of Card 2



This drastic change after the introduction of Card 2, meant that kids had started to think of a different ideas than what was projected as an example. What bought this "explorative" change? Why did kids started to work differently?

In both the scenarios, the procedure remained the same. What changed were the look and feel of the example cards shown to kids. This means the way the options were projected, changed. Connecting this point to the prospect theory[4] from the field of behavioral economics, which states that "People make decisions based on the way the options are framed". We see that kids chose to replicate the card on the basis of how they appealed their subconscious in visual form. If this choice is framed in a less appealing manner (as shown through Card 2), kids will not chose to replicate it.

However, some kids continued to replicate Card 1. Why was that so? Again, applying the decoy theory[5] from behavioral economics, which introduces a less-likely option to provide a space for better comparison. The less visually appealing card (Card 2), became the

“decoy” to the more visually appealing card (Card 1). This means, that when Card 2 was introduced, it provided a base of comparison for Card 1. Making Card 1 more powerful to Card 2, hence allowing kids a greater stand on their irrational value assessment, resulting in replicating of Card 1, again.

So, how does this connect to education pathways?
A lot of education today happens through “systematic instruction” as mentioned in the Introduction. Eliminating systemic instruction needs careful attention, as to which areas need elimination and which don't. A teacher can eliminate systematic instruction in math class by allowing students to explore different pathways to solve problems; but a chemistry teacher cannot afford to do so, as students might end up blasting the lab. In these situations the teacher needs to give systematic instruction to kids. So how can a teacher achieve this without circumscribing the ability of a kid to explore?

Here is where one can adopt “decoys” in class which smartly prompts the student to take an option by providing them with a less likely alternative. Also, the use of “prospects” drastically push students to think outside the box, as options provided are framed in a way which students feel the best.

To generalize, for providing guiding instructions and pushing kids to think outside the box, the use of decoy and prospect theory, respectively, from behavioral economics could be a good option to consider.

Experiment 3: Motivation testing

Motivation for kids is one of the most difficult tasks to conduct. A lot of motivation for kids come from replicating actions of the kids, and providing them for a more meaningful social connection during the workshop.

CircuiTricks, engaged kids by rewarding them with a Hi-Fi, each time a kid completed one step of an activity or created something new. The Hi-Fi had a great impact on the way kids reacted towards the CircuiTricks volunteer conducting the workshop.

A Hi-Fi, may sound kiddish, but that is the whole point. It snaps the kid to move from different thoughts to focus on one. Allowing the kid to be more excited towards the activity. Also, a Hi-Fi, at a deeper level, establishes a momentary relationship between the teacher and a student of a "friend". This allows the kid to put great trust within the teacher and work accordingly. Making the class easy for the teacher to manage and the student to be more focused!

Picture 4: Motivating kids during the CircuiTricks workshop

To generalize, for motivating students in classrooms, it is very necessary to for the teacher and student to develop a better yet momentary relationship of a "friend". This can be accomplished through simple gestures like giving a Hi-Fi as a means of a reward for better work!

Conclusion

One of the biggest reasons a lot of developing countries grow slowly is because of a lack of structured education system. A lot of institutions focus on “systematic instruction” rather than obtaining knowledge, while some education systems have also become synchronous with cramming!

With a prominence of this education system, we need to make knowledge more derivative through interactive hands on activities that better bring out learning within kids. This happens through the following simple process:

1) Provoking Curiosity : As resulted from experiment 1, provoking curiosity is a major factor of learning. This happens through improved content and can be regularly monitored through psychometric testing shown in in Experiment 1.
2) Using behavioral sciences to bring out “out of the box” ideas among kids and also help them focus as and when needed : As resulted from experiment 2, bringing out better ideas can happen after and while learning. This can be tested and implemented through the use of theories like “decoy” and “prospect” as shown in Experiment 2.
3) Motivating kids to do more : Motivating kids to do more can happen through simple gestures as mentioned in Experiment 3.

Limitations

The research work done in this paper to critically analyze the methods of better education, was very limited. The limitations are as follows:

Table 2: Limitations

Limitation	Absence of limitation
Recording and managing data during CircuiTricks became difficult due to lack of structured management.	The data obtained could be more accurate
Workshops provided us with more qualitative data than quantitative data.	Hard facts and targeted conclusions can easily be reached.

References

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3. Book: A little bit of CircuiTricks to pencil down your creations; Author(s): Nirman Dave; Page(s): 21; Publication year: 2014

4. Book: Behavioral Economics Guide 2014; Author(s): Alain Samson; Page(s): 2; Publication year: 2014

5. Book: Predictably Irrational; Author(s): Dan Ariely; Page(s): 15; Publication year: 2009